C. ALTERNATIVE TREATMENTS

1. Aquifer Storage Recovery

Aquifer storage and recovery involves the storage of treated water in underground rock formations. This can be described as the creation of an artificial aquifer of high water quality. In general practice, surplus treated water is injected into the rock formation and can then be recovered through a conventional well in times of need. The way that this would apply to the CIWC system is that water would be injected into the aquifer during low nitrate periods and would be recovered during high nitrate periods. The recovered water could then be blended with the higher nitrate water to reach a total blended nitrate concentration of less than 9 mg/l as N.

Aquifer storage and recovery is dependent upon suitable geology to properly store the injected product water. Ideally, the water would be injected into strata, which are isolated from surrounding formations by aquitards. These aquitards prevent leakage to formations below and contamination from formations near or at the surface above. The geology near the plant site is made up of a glacial drift of sand and gravel overlaying bedrock.

Due to the local geology in the area of the treatment facility, aquifer storage is not a viable alternative for this situation. The same soil properties which prevent aquifers from naturally forming in the area of the plant, will prevent an artificial aquifer from forming. The loose grained soils will likely result in excessive leakage from the artificial aquifer resulting in very poor retention of high quality water and/or excessive leakage to the stored water from the surface, carrying contaminants to the artificial aquifer.

2. Biodenitrification

Biodenitrification utilizes microorganisms to convert nitrate to nitrogen gas which is then easily removed. This approach is relatively new to the United States, but has been utilized to some extent in Europe. Biodenitrification is an anoxic process, which requires separate reactors. The process also requires a source of carbon, usually acetic acid, methanol, ethanol, or sodium acetate to provide food to the microorganisms. The microorganisms break down the nitrate (NO_3) to nitrogen gas (N_2) and utilize the oxygen released for respiration.

The microorganisms require a continuous supply of nitrate to remain in their non-dormant state. The process can be taken off line and the microorganisms maintained in a dormant state for long periods of time. However, a period of population development is required to bring the process back on line. Due to the inconsistent nature of the nitrate concentrations of the raw water, and especially the large changes in concentration which occur following a storm event, this process is of limited practical value for large scale nitrate removal at the CIWC. This may, however, be a viable method for treatment of the waste streams from ion exchange or reverse osmosis. For these reasons, biological denitrification is an infeasible treatment option for finished water for the CIWC.

3. Side Channel Storage

Side channel storage involves the stockpiling of high quality water for subsequent use when the raw water quality is poor. The two waters can then be blended to provide a source water that would meet the applicable drinking water standards.

a. System Description

Adjacent to CIWC owned land on the west side of the Vermilion River is a former active strip mine. This property, known as the Harmattan Strip Mine, contains several bodies of water which could be utilized to store low nitrate water. The stored water would be used for blending purposes to meet nitrate regulations, during the times of the year when the Lake Vermilion water is high in nitrates. The storage channels would need to be connected to the river intakes via a pipeline, allowing flow in both directions depending on the nitrate concentrations in the river.

b. System Requirements

Based on the design criteria as outlined in part B of this chapter, the required storage volume in the side channels would be 250 million gallons (MG). This volume is based on a 90 day period of nitrate treatment at a Lake Vermilion nitrate concentration of 12.7 mg/l, a side channel nitrate concentration of 3 mg/l and a 10 mgd total blended flow.

To date, CIWC has investigated the possibility of obtaining two different properties that encompass strip mine areas west of Danville. One landowner did not wish to cooperate while the other was open to negotiation. The location of this side channel storage area referred to as Canyon Lake is shown in Exhibit 7-9. CIWC worked previously with Daily & Associates Engineers, Inc., to investigate this option. Their data was used to develop this alternative. Their preliminary proposal indicates that Canyon Lake would be able to provide the storage requirement of 250 MG with the addition of an earthfill dam, 40 feet wide at the southwest end of Canyon Lake. The construction of a 24-inch diameter dual-directional flow pipeline between the raw water intakes at the river and the storage reservoir would be required. The routing of this pipeline would be along Hungry Hollow Road as shown in Exhibit 7-9. An estimated 24,000 lineal feet (lf) of pipe would be required. In addition, pump stations and intake structures would be required at both Canyon Lake and the river to transport the low nitrate water to and from the storage site. The Vermilion River pump station would be sized for a capacity of 8 mgd with one pump at 5800 gpm. The side channel reservoir pump station would be sized to send a variable rate flow up to 2800 gpm back to the plant, with one pump at 2800 gpm. Also, the existing upstream outlet of Lake Florence would have to be diverted north to an existing drainage ditch to prevent the intrusion of the storage site. Other considerations for this alternative include acquiring the necessary temporary and permanent easements and obtaining the required permits from the US Army Corps of Engineers, Illinois Environmental Protection Agency (IEPA), and the Illinois Department of Natural Resources (IDNR).

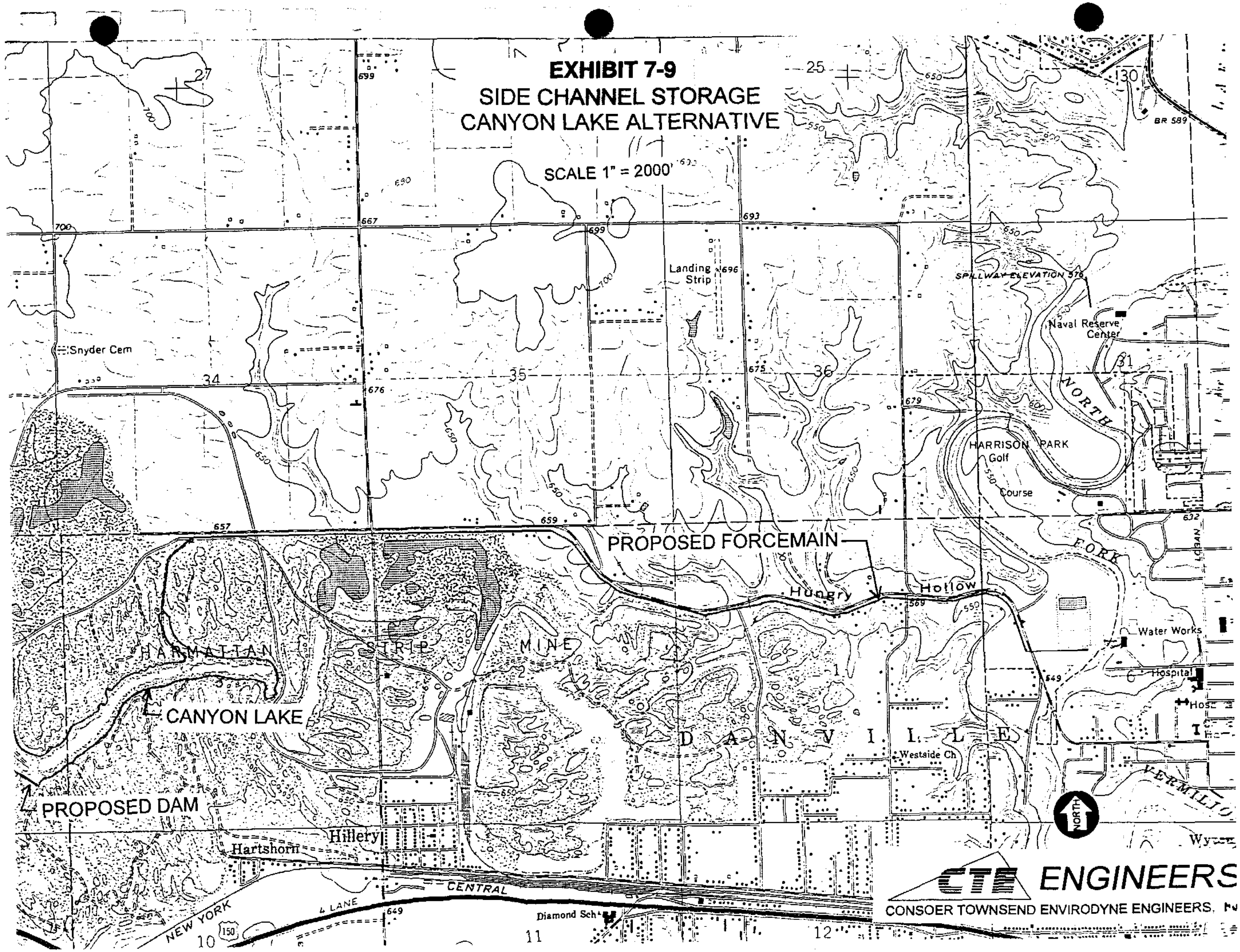
EXHIBIT 7-9
SIDE CHANNEL STORAGE
CANYON LAKE ALTERNATIVE
SCALE 1" = 2000'
PROPOSED FORCEMAIN
CANYON LAKE
PROPOSED DAM
Landing Strip
Snyder Cem
SPILLWAY ELEVATION 576
Naval Reserve Center
HARRISON PARK
Golf
Course
NORTH FORK
Hungry Hollow
HARMATTAN STRIP MINE
DANVILLE
Westside Ch
Water Works
Hospital
VERMILION
Hillery
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CTE ENGINEERS
CONSOER TOWNSEND ENVIRODYNE ENGINEERS, INC

The CIWC also investigated the possibility of obtaining a property north of the water treatment plant and west of Lake Vermilion, referred to as the Wright property, and CIWC obtained an option on another parcel of property east of the Wright property and immediately west of Lake Vermilion. The location of both properties with the associated forcemain routing is shown in Exhibit 7-10. Again, the possibility of utilizing one or both of these properties for side channel storage was preliminarily studied by Daily & Associates Engineers, Inc., and their data was used to develop these alternatives. In their feasibility study, three alternatives were developed for the two properties and are described below.

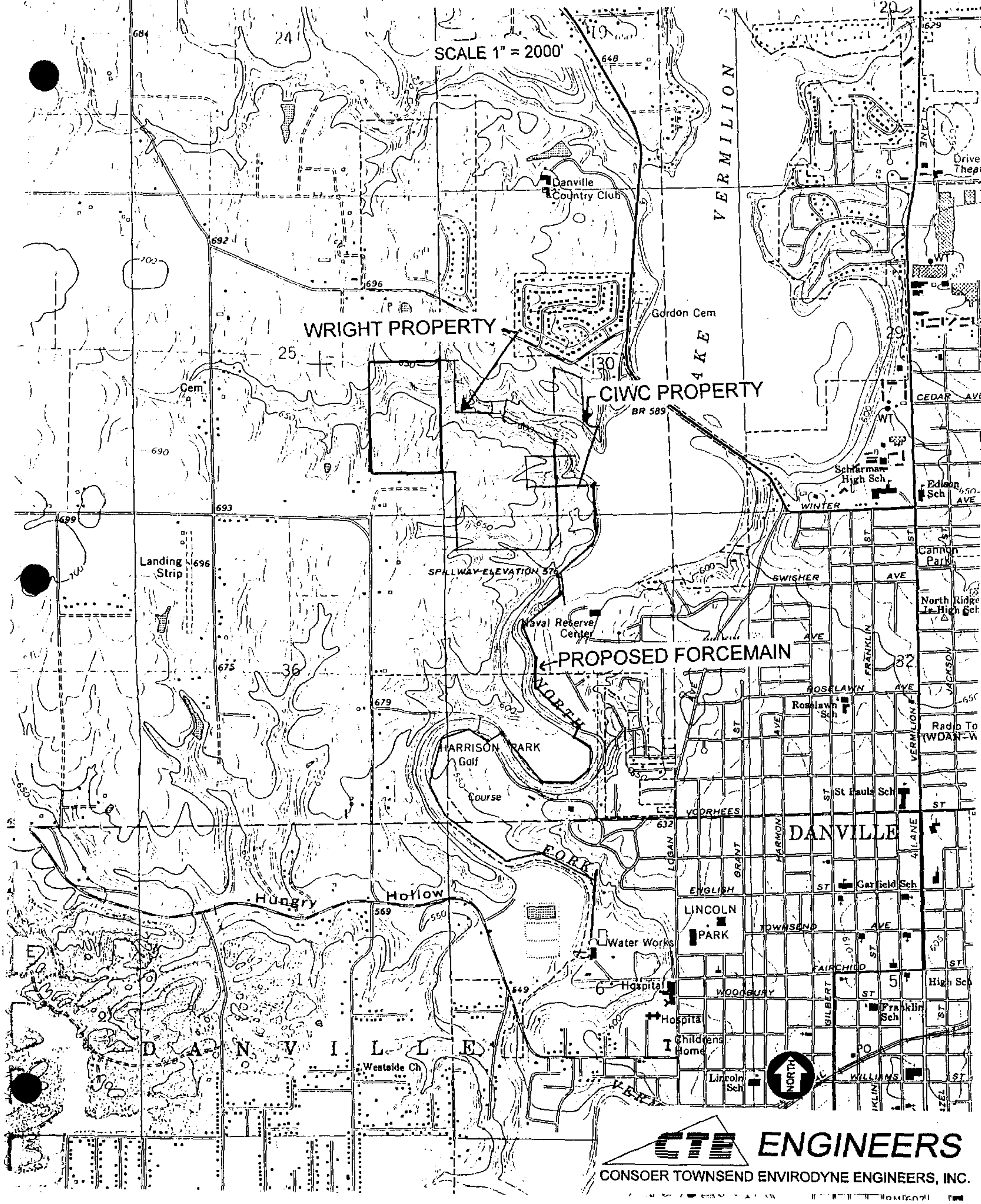
The first alternative involved using only the Wright property as a storage reservoir. It would provide a storage volume of 300 MG with the addition of a dam, which is 20% in excess of the minimum storage requirement of 250 MG. A dual-directional flow gravity/forcemain would be constructed with only one pump station located at Lake Vermilion near the dam so the pipeline from the lake pump station to the reservoir can be utilized both ways. Routing the 24-inch gravity/forcemain along the river would include approximately 14,500 lf of pipe and this route would minimize work at Harrison Park golf course. Possible environmental concerns for this alternative include: an IDNR permit would be required for construction of the forcemain along the waterway with possible impact on fishery, mussels and archaeological sites along the route; a significant amount of timber would need to be cleared in the side channel reservoir area, impacting the existing wildlife; erosion of slopes along Lake Vermilion would have to be monitored and an IEPA permit obtained; water quality and possible contamination of the proposed reservoir would have to be investigated; and major geotechnical work would be required to determine the feasibility of the site.

The second alternative involved constructing a dam across the bay on the west side of Lake Vermilion, which abuts CIWC's property. Excavation would need to be done on the CIWC's property as well as the Wright property to provide the 300 MG storage volume. A temporary cofferdam would be required to construct the dam in the bay of Lake Vermilion. Also an existing stream would need to be diverted around the reservoir site. The forcemain routing would be the same as the first alternative described above, located along the river.

The third alternative utilized an existing road embankment at the Chateau Estates road, which crosses the stream at the north end of the Wright property, using a steel sheet pile cut-off driven to rock through the embankment and buttressing the embankment with additional fill material to provide long term stability. Also, more excavation would be required at the Wright property to achieve the 300 MG storage volume. Again, an existing stream would be rerouted around the reservoir site.

In addition to environmental concerns for the first alternative, other concerns for the second and third alternates include: possible opposition by property owners; water quality concerns during construction on a tributary of Lake Vermilion; certain properties would need to be obtained or flood easements would be needed as the reservoir would extend onto certain properties; and the third alternative utilizes an existing roadway embankment as a dam; therefore, government approval would be necessary.

SIDE CHANNEL STORAGE
WRIGHT PROPERTY/CIWC PROPERTY ALTERNATIVES



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c. Summary

The side channel storage option is a feasible treatment alternative to meet the nitrate blending requirements. However, the success of this option depends on several factors which include the following: acquiring the necessary land and easements; obtaining the required permits; investigating the geology of the sites to determine if the lake levels can be raised or can support a dam structure; and determining if the water quality in the storage lakes is sufficient for blending purposes or if the possibility of contamination exists. CIWC as indicated above has exhaustively investigated the feasibility of possible side channel storage sites. From preliminary proposals prepared by Daily & Associates Engineers, Inc., the least cost alternative is utilizing the Canyon Lake site. Capital and operational costs for this option are detailed in Chapter 8 of this report.

4. Groundwater

An alternative to treatment of the existing surface water source is the use of a new water source. One method of accomplishing this is to utilize groundwater to replace or supplement the surface water system. CIWC has investigated the possibility of developing a groundwater source.

When CIWC first began looking into nitrate treatment alternatives, prior to 1992, the groundwater option was initially considered a favorable alternative when compared with the other alternatives due to low operating costs and minimal treatment requirements. At that time the length of nitrate treatment was expected to be 186 days per year, which favored finding a supplemental low-nitrate groundwater source. The groundwater source would provide additional benefits in addition to lowering the nitrate levels. A groundwater source would provide an additional source of supply, which was a critical issue during the 1990 drought, when through soundings it was determined that the Lake only had sufficient supply for 30 to 45 days. CIWC received a permit to raise the level of the Lake in 1991 but were still unsure as to what quantity of water the Lake would provide. Also, groundwater would provide a less vulnerable source of supply as Lake Vermilion has a 300 square mile watershed presenting many areas for potential contamination. Also, Safe Drinking Water Act (SDWA) Amendments were beginning to be formulated, specifically Disinfectants/Disinfection By-Products (D/DBP) rule and Interim Enhanced Surface Water Treatment Rule (IESWTR). The specifics of the rules were unknown at that point, but it was thought that by utilizing a groundwater source for the purpose of blending, any major concerns over turbidity, trihalomethanes (THMs), and SOCs would be reduced.

Due to the possible benefits of a groundwater source, the CIWC proceeded with their investigation to determine what areas might produce an adequate groundwater supply.

a. Available Groundwater

The geology of the area in the vicinity of the existing plant site and the North Fork of the Vermilion River consist of 400 to 500 feet of glacial sand and gravel deposits above bedrock. The bedrock is known as the Carbondale formation and is typically comprised of sandstone and limestone with pockets of shale, dolomite and coal. Testing previously performed by others for the CIWC indicates that there is little potential for developing a supplemental groundwater supply of 3 to 5 mgd from the sand and gravel aquifers in the area bounded approximately by Bismarck on the north, the Indiana-Illinois state line on the east, Danville on the south, and Jamesburg on the west[1]. This area covers approximately 152 square miles around Lake Vermilion and the City of Danville. Seismic refraction studies performed within public right of ways indicated that the area with the greatest potential for groundwater development is north and northwest of the study area in northern Vermilion County near the Village of Henning. Resistivity data and water well logs from this area indicate that the Mahomet Sand aquifer is widespread. The Mahomet Sand aquifer is a proven high capacity aquifer serving many areas of the state with drinking water.

Testing of this area was delayed due to landowner opposition, which resulted in legal proceedings. However, during this time one property owner, CSX Transportation, granted CIWC permission to initiate exploratory borings along the Chicago and Eastern Illinois Railroad right of way in the area of the Village of Henning. Over a two-year period, a total of six test borings were drilled. The test boring program identified two aquifer formations in the area. The first is the Glasford Formation encountered at depths of 60 to 130 feet. It is currently being used by residents as a domestic water supply. The high silt content of the formation makes it unsuitable for development of high capacity wells. The second formation encountered is the Banner Formation at depths of 200 to 253 feet. This formation, while thin (as little as 30 feet in the test area) has the potential for the higher capacity that would be required to serve CIWC.

None of these test borings has been developed into test wells. Therefore, site specific data on the aquifer is not available. For the purposes of this study, CTE has utilized data from previously developed Banner Formation wells. These indicate the following aquifer characteristics for the Banner Formation:

Transmissivity (gpd/ft)	9,000 – 296,000
Hydraulic Conductivity (gpd/ft^2)	700 – 5,300
Storage Coefficient (confined)	$1 \times 10^{-5} - 1 \times 10^{-3}$

Likewise, water quality data for the Banner Formation has been developed based upon area wide water quality for this aquifer as follows:

[1] David R. Larson, John P. Kempton and Scott Meyer, Geologic, Geophysical, and Hydrologic Investigations for a Supplemental Municipal Groundwater Supply, Danville, Illinois, Illinois Department of Natural Resources, Cooperative Groundwater Report No. 18, 1997.

	RANGE	MEAN
Total Dissolved Solids (mg/l)	308 – 2,936	639
Hardness as $CaCO_3$ (mg/l)	110 – 752	338
Alkalinity (mg/l)	252 – 552	430
Dissolved Iron (mg/l)	0.4 – 17.5	4.4

The calculated capacity of the Banner Formation in the vicinity of Henning ranges from 270,000 to 14,800,000 gallons per day. Until a well is developed in the formation, a definitive capacity is unknown. For cost analyses purposes, it was assumed that the required capacities of groundwater could be developed via typical methods in the Henning area, which is the most favorable location with respect to the treatment plant, resulting in the lowest possible cost for a groundwater source. Therefore, it should be noted that if adequate capacities of groundwater could not be developed near the Village of Henning, an alternate site would increase the length of the pipeline needed to transport the water to the plant, which would increase the overall cost of the groundwater option.

b. Required Groundwater

Assuming that the water quality of the wellfield is as discussed above and also that the groundwater has a negligible nitrate concentration, the developed wellfield would be required to have a capacity of approximately 2.9 mgd. This is the quantity required to blend with surface water at 12.7 mg/l, which is the average historical nitrate concentration during high nitrate events, to produce a minimum of 10 mgd of finished water with a nitrate concentration of less than 9 mg/l as N.

Adding some capacity for losses, the wellfield should be designed for a reliable capacity of approximately 3 mgd.

c. System Description

The wellfield would consist of four wells with a total reliable capacity of approximately 3 mgd and a maximum capacity of 4 mgd. The well discharges would be combined to form a single pipeline, which would carry the water to the existing water treatment plant site, a distance of approximately fourteen miles. The transmission main would carry untreated groundwater and would be designed to carry approximately 150% of the required flow to allow for additional flow, if necessary. The pipeline would be 20-inch diameter HDPE and would carry the water from the wells to the treatment plant site. The groundwater would be mixed with the surface water in a new mixing structure or within the raw water piping. The blended water would then be softened, filtered and disinfected through the existing water treatment plant.

The blending system would be utilized whenever the surface water nitrate concentration is at or above a recommended pre-set level of approximately 9 mg/l and rising.

The well system could be automated to allow for remote pump operation and monitoring from the treatment plant. This would allow the duty operator to control both sources, and thus, the finished water nitrate concentration, from one location, eliminating the need for an operator to drive to the wellfield to make flow adjustments in response to varying surface water conditions.

d. Results/Conclusions of Groundwater Investigation

Although CIWC was ultimately granted permission by the courts to perform groundwater testing, CIWC did not go forward with the testing based on further consideration and developments. As more nitrate data became available for the years following the raising of the Lake, a pattern of a decrease in nitrate violations and duration became apparent as discussed previously in this chapter of the report. Therefore, the number of expected days per year of nitrate treatment was reduced, which then made other alternatives, specifically ion exchange, more favorable from a cost standpoint, even when assuming that groundwater would be available near the Village of Henning, which would be at the most favorable location with respect to the treatment plant.

In addition, both a safe yield study and a sedimentation study were performed on the Lake in 1997 and 1998, respectively. Both studies indicated that there is adequate water in Lake Vermilion for the future under a variety of drought conditions (up to a 50-year drought). Also, the D/DBP rule and the IESWTR were formulated and did not result in as stringent of standards as anticipated, which further reduced the need for groundwater as a second supply.

e. Summary

Blending utilizing a groundwater source is a viable option from a technical standpoint. However, based on the results and conclusions of the initial groundwater investigation and in light of recent developments with regard to the current nitrate situation, it is not a feasible option due to the associated costs when compared with other alternatives. The cost analyses for the most favorable groundwater option are developed in Chapter 8 for capital and operating and maintenance costs as well as present value revenue requirements. In addition, there are several risks associated with this alternative, which include the possibility that sufficient groundwater is not available and that it would be difficult to acquire the needed land for well development. There is considerable landowner opposition to the development of a "rural" groundwater site to serve the people of Danville. Also, additional testing would be required to determine the extent of the viability of this alternative.

5. Ion Exchange

An alternative approach to supplementing the surface supply is further treatment of the existing supply. One method of reducing nitrates utilizes an ion exchange resin to exchange more desirable ions for the less desirable nitrate ions in solution.

a. Process Description

In the ion exchange process for nitrate removal, nitrate containing water passes through a media bed comprised of a high capacity anion exchange resin with a final gravel support media. Nitrates, sulfates, and alkalinity are exchanged for chlorides on the strongly basic anion resin.

The exchange capacity is largely governed by the concentrations of nitrates and sulfates which are retained until breakthrough of unwanted ions occurs. Prior to breakthrough, sometimes called exhaustion, the process is regenerated using a strong chloride solution. The basic chemical reactions are reversible as follows:

In Service:

$$RCl + NaNO_3 = RNO_3 + NaCl$$

Regeneration:

$$RNO_3 + NaCl = RCl + NaNO_3$$

where R = anion exchange resin.

The basic ion exchange process is configured in several modes. The first, called co-current regeneration, regenerates the resin in the same flow direction as the in-service flow. This mode requires a backwash following each service run to relieve compaction of the bed and remove any collected particulates.

The second mode, referred to as counter-current regeneration, utilizes an upflow regeneration and slow rinse and a downflow in-service configuration. This results in lower leakage rates through the bed. The major disadvantage of this system is that higher capital costs are required to configure the two flow modes. This must be compared against lower operation and maintenance costs and higher quality effluent.

The third mode, known as a continuous contactor, never takes the reactor out of service. Instead the resin bed is moved through a cycle in which a portion of the resin is constantly being regenerated. The disadvantages of this system are the higher capital and maintenance costs.

Each of the three ion exchange operating configurations were investigated and then evaluated based on cost and operating parameters. The following Table 7-2 summarizes the operating parameters for each mode based on Hungerford & Terry co- and counter-current systems and on Advanced Separation Technologies for the continuous ion exchange system. The cost analyses for each of the three ion exchange options are developed in Chapter 8.

TABLE 7-4
ION EXCHANGE OPERATING MODES

ITEM	CO-CURRENT	COUNTER-CURRENT	CONTINUOUS CONTACTOR
No. of Exchange Units	4	4	30
Normal Pressure Drop, psi	10	10	10
Max. Pressure Drop, psi	25	25	25
Control	PLC	PLC	PLC
Bulk Brine Tank, Tons	88	88	72
Water Softener	No	Yes	Yes
Ion Exchange Resin, cu. ft.	1256	1572	725
Waste Per Treated Water	19 gal/1000 gal	14 gal/1000 gal[1]	4 gal/1000 gal
Waste Produced Per Yr.	1.63 MG	1.14 MG	0.32 MG
Salt Per Treated Water	4.0 lb/1000 gal	2.7 lb/1000 gal	2.5 lb/1000 gal
Salt Usage Per Yr.	170 tons	105 tons	98 tons
Footprint	40 ft x 50 ft	40 ft x 50 ft	36 ft x 50 ft

[1]Assumes use of air-blocking during regeneration. Air blower is included.

Regardless of the mode, the ion exchange process generates a waste stream, which contains concentrated nitrates that have been removed and must be disposed of properly. The Sanitary District has indicated that they would accept this nitrate waste based on a total annual volume charge and a sulfate loading surcharge. If this method of disposal would be implemented, additional force main would have to be constructed, and the current lift station would have to be expanded to effectively convey this waste to the Sanitary District. Alternatively, CIWC could explore the possibility of obtaining a new National Pollutant Discharge Elimination System (NPDES) permit, which would allow the waste stream to be directly discharged to a receiving stream. One possible discharge point would be Horseshoe Pond, which is located in front of the treatment plant. Another option would be to modify an existing NPDES permit to allow the waste to be discharged to the existing sludge lagoons. These options should be explored as either would provide considerable cost savings when compared to discharging to the Sanitary District.

b. System Requirements

Based on the cost analyses detailed in Chapter 8 for the different ion exchange alternatives, the low cost alternative was further considered for this report, which is the counter-current system. Both previous studies with Lake Vermilion water and recent correspondences with an ion exchange manufacturer indicate that an effluent nitrate concentration of 2 mg/l would be easily achievable given both the average and maximum historical influent values of 12.7 and 15.6 mg/l, respectively. In order to meet the finished water goal of 9 mg/l as N, it would be required to treat only a portion of the influent for nitrate. The balance could be "blended around" this process, and the combined water would then safely meet the standard.

The overall treatment capacity goal would be 10 mgd of finished water at less than 9 mg/l of nitrate as N based on average and maximum influent nitrate concentrations of 12.7 and 15.6 mg/l, respectively. At worst case conditions, this would require a reliable ion exchange capacity of 3056 gpm. This capacity could be provided through four treatment vessels each with a treatment capacity of 764 gpm. The four vessels would provide the required total maximum capacity. At average conditions, the required flow to be treated by the ion exchange system would be 1821 gpm, which could be provided through three treatment vessels with one unit out of service for regeneration or repair.

The ion exchange system would be housed in a prefabricated steel structure enclosing an approximate surface area of 3000 square feet. The structure would be located at the north end of the existing reservoir. The flow configuration would include the conventionally filtered water piped into the existing reservoir with a fraction being discharged into the reservoir and the required balance would be piped to the ion exchange system. The effluent from the ion exchange system would then be discharged into the reservoir. The structure location and piping configuration is shown in Exhibit 7-11.

c. Summary

The ion exchange process is a feasible treatment alternative from a technical standpoint because it provides a low nitrate concentration effluent, which could be blended to meet the nitrate finished water goal of 9 mg/l N. This option also requires salt for regenerations and periodic resin replacement. The waste disposal cost for this alternative is based on discharging to the Sanitary District. However, the option of obtaining a new NPDES permit or modifying an existing permit should be investigated as it would provide considerable savings when compared to discharging to the Sanitary District. As mentioned previously, capital and operating costs for all three ion exchange alternatives are included in Chapter 8.

5. Nanofiltration

Nanofiltration is a membrane-based process similar to reverse osmosis. Nanofiltration is sometimes referred to as "leaky reverse osmosis." Basically, the process utilizes pressure to force water through a semi-permeable membrane. The membrane systems used for nanofiltration are capable of rejecting contaminants as small as 0.001 μm. Nanofiltration also has been shown to completely reject contaminants with a molecular weight greater than 190 to 200 daltons. The molecular weight of nitrate is considerably lower than this. Therefore, a significant portion of the nitrate is allowed to pass through to the product water. Because there would not be significant nitrate reduction in the nanofiltration effluent, this technology is infeasible for the given situation.

6. Reverse Osmosis (RO)

The most significant difference between reverse osmosis and nanofiltration is that the density of the membrane is greater for RO, which results in a lower molecular cut off weight. As a result of the increased membrane density, a greater pressure differential across the membrane is required to drive the process with pumping requirements ranging from 100 to 300 psi.

RO systems can reliably reject constituents as small as 0.001 μm, or in terms of membrane weight cutoffs, as small as monovalent ions. Consequently, RO systems can effectively remove nitrates.

a. System Description

Typically, RO systems are configured in arrays to generate as large a recovery as possible. Typically, recovery of permeate through any one element is limited to approximately 75%, which means that only 75% of the influent volume is collected as finished water or permeate. The balance of the water remains as concentrate, and the constituents rejected by the membrane are effectively concentrated in this stream. In an array configuration, the concentrate from the first set of modules is then passed through a second set of modules to increase the overall permeate recovery. Typically, this step is repeated one last time to achieve up to 94% recovery through a 4:2:1array.

The high pressures required to force permeate through the semi-permeable membrane require a pumping system dedicated to the RO process. Other appurtenances required include pretreatment (antiscalant) chemical storage and feed equipment, a degassifier, an automatic control system, and a membrane cleaning system including tanks, pumps and controls. In addition, the concentrate waste stream would have to be disposed of properly. One option would be to discharge it to the sanitary sewer, where total annual volume charges and sulfate surcharges would be applied by the Sanitary District and upgrades to the existing wastewater facilities, as described above for the ion exchange process, would be required.

b. System Requirements

Based on the chemistry of Lake Vermilion water, RO system manufacturers project that an RO permeate would have a nitrate concentration of approximately 1.2 mg/l based on an influent nitrate concentration of 12.7 mg/l, the historical average during high nitrate events. Based on this influent concentration and the overall goal of providing 10 mgd capacity of finished water with an effluent nitrate concentration of less than 9 mg/l, an RO capacity of at least 3.2 mgd (2220 gpm) is required. This could be accomplished through two (2) 4:2:1 arrays of modules totaling 42 pressure vessels each (24 first phase, 12 second phase and 6 third phase). This system would be capable of producing 2220 gpm of permeate with a nitrate concentration of 1.2 mg/l as N. This would also produce approximately 145 gpm of concentrate to be disposed of from a total influent of 2360 gpm. This is based on a recovery rate of 94%. Also, 4720 gpm of non-RO treated water would be by-passed around the system to yield 6945 gpm or 10 mgd of blended water with a nitrate concentration of less than 9 mg/l as N. At times when the demands and influent nitrate concentrations are lower than the assumed design parameters, the volume of blended water would be increased and the output of the RO system decreased. At times when the influent nitrate concentrations are above the 12.7 mg/l high nitrate event average, the units can be "pushed" for a period of time. This would result in an accelerated cleaning requirement but enable the Water Company to continue to meet the MCL.

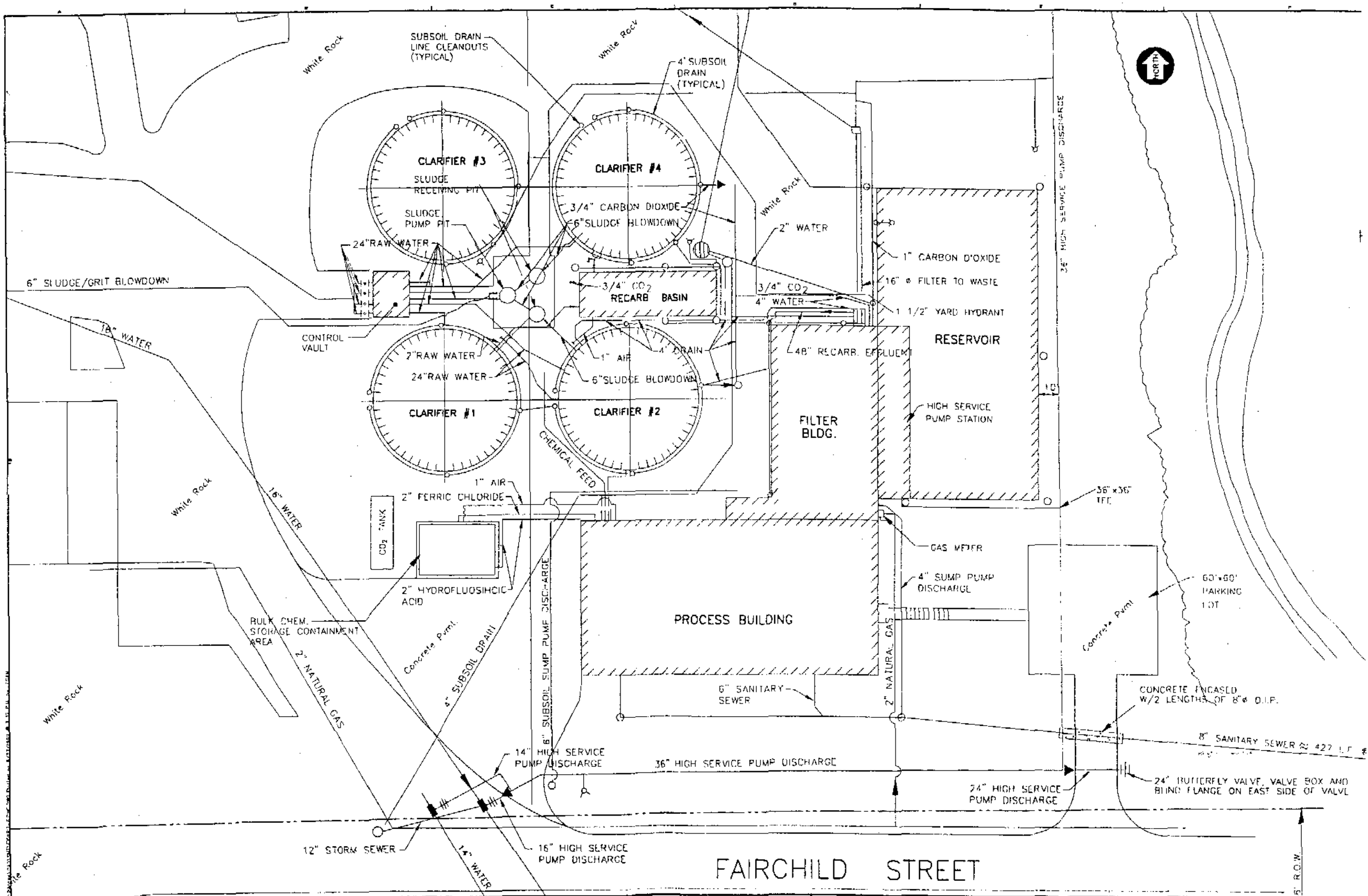
The RO system could also be taken off line for long periods of time when nitrate levels are well below the 10 mg/l standard.

Assuming that the plant's effluent would be the feed to the RO system, the RO influent would require a sufficient dose of sulfuric acid to bring the pH of the water down from 8.8 to 7.0, which would require approximately 470 lb/day at design capacity. The process would also require an antiscalant dose of approximately 2 ppm to prevent formation of calcium sulfate due to the addition of acid. The RO permeate would be treated by a degassifier which would remove the dissolved carbon dioxide from the permeate and decrease the aggressive nature of the product water.

The RO system would be housed in a prefabricated steel structure enclosing an area of 2520 square feet located north of the existing reservoir, and the piping configuration would be the same as was previously described for the ion exchange system. Exhibit 7-11 illustrates the structure location and piping configuration.

c. Summary

Reverse osmosis would effectively treat the high nitrate concentrations providing an effluent that is less than 2 mg/l, which would result in an overall blend below the 9 mg/l goal. Capital and operational costs for this alternative are discussed in Chapter 8.



REVISIONS	DESIGNED CAH	SCALE 40 0 40 80 FEET	CONSUMERS ILLINOIS WATER COMPANY DANVILLE (VERMILION) WATER TREATMENT PLANT IMPROVEMENT PROJECT	CTE ENGINEERS CONSOER TOWNSEND ENVIRODYNE ENGINEERS, INC.	EXISTING SITE PLAN	SHEET EXHIBIT 6-1
	DRAWN LRL					OF
	CHECKED WER					
	DATE AUGUST, 1999					CTE PROJECT NO. 4414

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